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(54) Title: COMPONENT FOR A PIPE-LINE WASTE-WATER SYSTEM

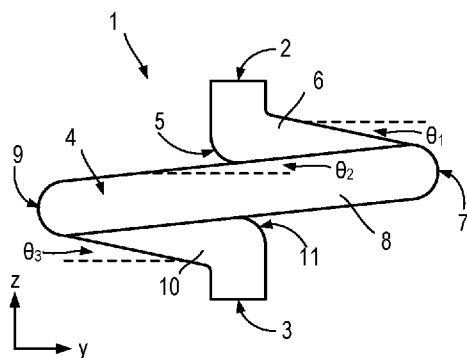


Fig. 2B

(57) Abstract: A component (1) for a pipe-line system for waste-water in a building is described. The component includes an inlet (2) connected to an outlet (3) by a tube (4) shaped such that there is no straight-line path passing uninterrupted through the tube between the inlet (2) and outlet (3). The tube (4) includes a portion which follows a U-shaped path. The tube (4) is shaped such that it can be aligned relative to gravity with the inlet (2) above the outlet (3) and every part of the tube sloping downwards. The tube (4) includes, or take the form of, anti-microbial material or is internally lined with anti-microbial material.

Component for a pipe-line waste-water system

Field

The invention relates to a component for a pipe-line waste-water system, in particular
5 to reducing or preventing bacteria or other pathogens from spreading from a trap back
to a drain, for example a sink outlet.

Background

Colonised drain pipes of sinks, washbasins, sluices, showers, baths and similar sanitary
10 ware products have been associated with many outbreaks of multi-resistant bacteria
and may be one of the main causes of the current antibiotic resistance crisis.

Current drains descend vertically into a trap, for example a U-bend, which is full of
dirty water which harbours many bacteria including multi-resistant ones. Such traps
15 are needed to prevent odours from drains passing up into rooms, and consequently the
risk from the potential reservoir of bacteria and other pathogens cannot be removed,
only mitigated.

E.C. Deasy *et al.*, "Minimizing microbial contamination risk simultaneously from
20 multiple hospital washbasins by automated cleaning and disinfection of U-bends with
electrochemically activated solutions", Journal of Hospital Infection 100, e98-e104
(2018) describes a sequential treatment with a highly oxidising anolyte solution
followed by a highly basic catholyte solution.

25 US 10,550,015 B2 describes an active, powered system used to disinfect a U-bend.

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Summary

According to a first aspect of the invention, there is provided a component for a pipe-line system for waste-water in a building, including an inlet connected to an outlet by a tube shaped such that there is no straight-line path passing uninterrupted through the tube between the inlet and outlet. The tube comprises a portion which follows a U-shaped path. The tube is shaped such that it can be aligned relative to gravity with the inlet above the outlet and every part of the tube sloping downwards. The tube includes, or takes the form of, anti-microbial material or is internally lined with anti-microbial material.

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In normal use (i.e. in the absence of flooding and/or downstream blockages), water may not be retained in any portion of the component. In other words, this means that there is no standing water in the component. The exclusion of standing water does not preclude the presence of droplets of water within the component, or that some portions of the component may remain wetted.

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References to the geometry of the tube may refer to a path which runs through a centre of the cross-section of the tube at each point. The cross-section of the tube may be substantially constant in shape and area. The inlet may be above the outlet if the centre of the inlet is above the centre of the outlet. A cross-section of the inlet may overlap vertically with a cross-section of the outlet.

20

Alignment relative to gravity may mean that a reference direction exists relative to the component such that when the reference direction is aligned with gravity, the inlet is above the outlet and every part of the tube slopes downwards. More than one possible reference direction may exist for the device. A cone of reference directions satisfying the criteria may exist. The key point is whether any reference direction satisfying the criteria exists.

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When the component is installed between a drain and a trap, the absence of an uninterrupted straight-line path passing through the tube between the inlet and the outlet may help to reduce or prevent backsplash droplets generated at the trap from passing back up to the drain. This may help to reduce the spread of bacteria which may persist in the trap (in part because such elements typically do not dry out in routine use).

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The trap may be a P trap, an S trap, a Q trap, a gully trap, a bottle trap, an intercepting trap, a grease trap, a drum trap, a running trap, a straight through trap, a low-level bath trap, a building trap. The trap may be a U-bend.

- 5 The constant slope in the tube (that is, every part of the tube sloping downwards) means that, when the component is installed between a drain and a trap, residual water in the tube of the component will be minimised. The less damp the path between the drain and the trap, the harder it may be for a biofilm to colonise back up towards the drain.

10

The use of anti-microbial materials, whether bulk or an internal lining, may help to slow, or even prevent, biofilms from spreading from the trap through the component and towards the drain. Additionally, the shape of the tube so that there is no straight-line path between inlet and outlet means that, for given spacing of inlet and outlet, the path through the tube is lengthened compared to a direct path. Increasing the length of pipe and tube which a biofilm needs to colonise before reaching the drain may also help to further reduce the chance of bacteria or other pathogens reaching the drain.

15

The tube may include a structure proximate to the inlet and configured to reduce or prevent generation of backsplash droplets in response to fluid incident through the inlet. Proximate to the inlet may mean within 10% or less of a total path length between the inlet and the outlet.

20

In this way, even if a biofilm is able to spread up through the component, the reduced generation of backsplash droplets, compared to fluid falling into standing water of a trap, may help to further reduce the risk of bacteria escaping from a connected drain.

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The structure may include, or take the form of, a slope and/or a curvature of the tube wall following the inlet. When the component is installed between a drain and a trap, fluid and/or droplets from the drain fall into the inlet generally in the direction of gravity. The slope and/or curvature of the tube wall may be arranged such that such fluid and/or droplets hit the slope or curvature of the tube wall at an angle away from 90°. In this way, backsplash droplets may tend to be deflected about the normal to the tube wall instead of back out through the inlet. The slope and/or curvature may form a 'ski-jump slope', such that when the tube is aligned relative to gravity, fluid falling in through the inlet experiences a gradient which decreases as it descends.

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The structure may include, or take the form of, a plurality of protrusions supported on a portion of the tube wall onto which a fluid incident through the inlet impacts.

- 5 The structure may include, or take the form of, a mesh and/or a grating spanning the tube.

The structure may include, or take the form of, any type known from use in urinals for reduction or prevention of backsplash, and/or from use in sinks for reduction or
10 prevention of backsplash. Whilst known for such purposes, to the applicant's knowledge such structures have not previously been used below a drain, within a channel connecting the drain to the trap.

The tube may include a portion which follows a helical path. The tube may take the
15 form of the portion which follows the helical path. The inlet and outlet may be connected to the tube by respective connecting portions. The connecting portions may take the form of elbow joints. The connecting portions may be integrally formed with the tube. The connecting portions may be separate from the tube, and joined using appropriate coupling means such as, for example, an O-ring compression fitting.

20

A pitch and/or a radius of the helical path may vary along an axis of the helical path.

The tube may take the form of the portion which follows the U-shaped path. A U-shaped path may alternatively be described as hairpin shaped. A U-shaped path may
25 progress monotonically between a starting angle and a finishing angle, with a difference between the starting angle and the finishing angle being less than 180°. The inlet and outlet may be connected to the tube by respective connecting portions. The connecting portions may take the form of elbow joints. The connecting portions may be integrally formed with the tube (for example, as bends). The connecting portions may be
30 separate from the tube, and joined using appropriate coupling means such as, for example, an O-ring compression fitting.

The tube may include a portion which follows a serpentine path. The tube may take the form of the portion which follows the serpentine path. The serpentine path may
35 include, or take the form of, two or more U-shaped portions connected end to end. The serpentine path may have a generally sinusoidal shape. The inlet and outlet may be

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connected to the tube by respective connecting portions. The connecting portions may take the form of elbow joints. The connecting portions may be integrally formed with the tube. The connecting portions may be separate from the tube, and joined using appropriate coupling means such as, for example, an O-ring compression fitting.

5

The anti-microbial material may include, or take the form of, a metal. The metal may be an alloy. The metal may be an alloy of two or more metallic elements.

10 The metal may include, or take the form of, copper. Copper may take the form of pure or substantially pure copper (for example for a coating or lining), or a copper alloy such as 6000 series alloy copper, 7000 series alloy copper, brass, bronze, or copper-nickel. The metal may include, or take the form of, a lead alloy.

15 Alternatively or additionally, the anti-microbial material may comprise or take the form of silver or an alloy thereof. The anti-microbial material may take the form of a plating of silver on an interior surface of a less precious metal tube. For example, a solution of silver nitrate may be used for a displacement reaction to form a silver layer on the interior surface.

20 Alternatively, the anti-microbial material may take the form of an organosilane or quaternary ammonium compound. Organic anti-microbial materials may be incorporated in a polymer such as polyvinyl chloride (PVC) or polypropylene (PP), or may be applied as a surface treatment to such polymers. Alternatively, anti-microbial material in the form of powders, flakes, wires and so forth may be embedded in a
25 polymer matrix or otherwise incorporated in the polymer matrix. For example, powders, flakes or wires or the metals described herein.

The tube may be composed of the metal. When included, the connecting portions may be formed of the same or a different metal as the tube. When included, the connecting
30 portions may be formed of plastic, for example PVC or PP.

When the tube is formed from metal, it may be heated to relatively high temperatures using an external heat source such as a heat gun. The heat will be efficiently conducted to the interior surfaces, causing efficient drying of residual water within the tube.
35 Additionally, if any biofilm has formed on the tube interior, the drying may help to kill the film, or to reduce adhesion and/or cause spallation of the drying film to facilitate a

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subsequent rinsing operation. If the temperature is raised high enough, for example to within the range of 60°C or more, then some bacteria and other biofilm forming organisms may be killed (though higher temperatures would be needed before using the term sterilisation, for example 120 °C).

5

In this way, the presence and/or growth of a biofilm across the component and towards a connected drain may be reduced or prevented.

10 A length of the tube may be such that when a midpoint of the tube is raised to a temperature between 60 and 100 degrees Celsius, the maximum of a temperature at the inlet and a temperature at the outlet remains at least 10 degrees Celsius lower than the temperature at the midpoint of the tube.

15 These conditions may refer to thermal behaviour of the tube in ambient conditions corresponding to standard temperature, pressure and a humidity within the range of 30 to 60%.

20 In this way, the length, and often tortuous shape, of the metal tube, coupled with radiative and surface heat losses from the metal tube surfaces, may allow the temperatures at the tube ends (corresponding to, or at least proximate to the inlet and outlet) to remain at lower temperatures. This may allow higher temperatures to be applied to the metal tube at its centre, without imposing undue thermal stresses and/or aging on connected components, for example polymeric components connected to the inlet and/or outlet.

25

A pipe-line system for waste-water in a building may include the component, connected between a drain and a trap.

30 The drain may be the drain of a sink, such as a washbasin. The drain may be the drain of a shower, a bath, or a bidet. The drain may be a drain of a dishwasher or a washing machine. The drain may be a drain of a sluice in a hospital. The drain may be a drain of a wet room. The drain may provide an outlet for waste-water from any domestic, industrial, agricultural or medical plumbing.

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The system may be used in a house, a hospital, a farm, an abattoir (slaughterhouse), a nursing home, an airport, a railway station, a plant for preparing, processing or

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manufacturing food, a restaurant, a nursery, a school, or any other location in which infection control is a concern.

5 The inlet of the component may be directly connected to the drain. Alternatively, the inlet of the component may be connected to a pipe descending vertically from the drain.

The outlet of the component may be directly connected to the trap. Alternatively, the outlet of the component may be connected to a pipe descending vertically to the trap.

10 The trap may be connected to a sewage system. The trap may be connected to a septic tank.

The component may be sized for commercial, residential or industrial drains.

15 According to a second aspect of the invention, there is provided a pipe-line system for waste-water in a building including a component connected between a drain and a trap. The component includes an inlet connected to an outlet by a tube shaped such that there is no straight-line path passing uninterrupted through the tube between the inlet and outlet, and the tube is arranged relative to gravity with the inlet above the outlet
20 and every part of the tube sloping downwards.

In this way, a length of a path between the drain and the trap may be increased. This may help to reduce the spread of bacteria from the trap to the drain, as described hereinbefore in relation to the component of the first aspect and a system incorporating
25 the component.

The system according to the second aspect may include features corresponding to any features of the component according to the first aspect or a system incorporating that component. Definitions applicable to the component according to the first aspect (or
30 features thereof) or a system incorporating that component (or features thereof) may be equally applicable to the system of the second aspect.

In the system of the first or second aspects, the inclusion of the component may increases a path length between the drain and the trap by a factor of at least 1.5
35 compared to connecting the drain directly to the trap. The inclusion of the component may increase a path length between the drain and the trap by a fraction of at least 2

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compared to connecting the drain directly to the trap. The inclusion of the component may increase a path length between the drain and the trap by a fraction of at least 3 compared to connecting the drain directly to the trap. The inclusion of the component may increase a path length between the drain and the trap by a fraction of at least 5
5 compared to connecting the drain directly to the trap.

In the system of the first or second aspects, in normal use (i.e. in the absence of flooding and/or downstream blockages), water is not retained in any portion of the component. In other words, this means that there is no standing water in the
10 component. The exclusion of standing water does not preclude the presence of droplets of water within the component, or that some portions of the component may remain wetted.

According to a third aspect of the invention, there is provided a kit of parts including
15 the component of the first aspect, a first connector for connecting the inlet of the component to a drain, and a second connector for connecting the outlet of the component to a trap.

At least one of the first connector and the second connector may respectively comprise
20 a curved part, for example an elbow bend, formed of a plastic material, optionally polyvinyl chloride (PVC) or polypropylene (PP). The first and/or second connector may be connectable to the component using any suitable means, including but not limited to, adhesives, compression fitting, the connectors may screw directly onto the component, and so forth. If the first and/or second connectors are metals, they may be
25 connectable to the component by brazing or soldering.

The kit according to the third aspect may include features corresponding to any features of the component according to the first aspect, the system incorporating that component, and/or the system according to the second aspect. Definitions applicable
30 to the component according to the first aspect (or features thereof) or a system incorporating that component (or features thereof) may be equally applicable to the kit of the third aspect.

According to a fourth aspect of the invention, there is provided a method of fitting the
35 component of the first aspect to a pipe-line system for waste-water in a building which

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includes a drain connected to a trap. The method includes replacing all or part of a connection between the drain and the trap with the component.

5 The method according to the fourth aspect may include features corresponding to any features of the component according to the first aspect, the system incorporating that component, and/or the system according to the second aspect. Definitions applicable to the component according to the first aspect (or features thereof) or a system incorporating that component (or features thereof) may be equally applicable to the method of the fourth aspect.

10

According to a fifth aspect of the invention there is provided a method applicable to the systems of the first or second aspects, when the tube of the component is formed of metal. The method includes using a heat source to heat the tube to a temperature between 60 and 100 degrees Celsius for a time period at least long enough to cause
15 drying of the interior surface of the tube.

The heating may be carried out using a heat gun. Heat from the heat gun may be applied at or around a midpoint of the tube.

20 The time period may be at least long enough to kill or comprise a biofilm formed on the interior of the tube. The time period may be at least 5 minutes. The time period may be between 5 and 10 minutes (inclusive of end-points). The time period may be longer than ten minutes.

25 The method according to the fifth aspect may include features corresponding to any features of the component according to the first aspect, the system incorporating that component, and/or the system according to the second aspect. Definitions applicable to the component according to the first aspect (or features thereof) or a system incorporating that component (or feature thereof) may be equally applicable to the
30 method of the fifth aspect.

Brief description of drawings

Figure 1A is a photograph of a first exemplary component in accordance with the present specification;

Figure 1B is a photograph of the first exemplary component from the side;

5 Figure 2A is a schematic plan view of the first exemplary component;

Figure 2B is a schematic side view of the first exemplary component;

Figure 2C is a schematic side view of the first exemplary component from the opposite direction to Figure 2B;

Figure 3 is a schematic side view of a second exemplary component;

10 Figure 4 is a schematic side view of a third exemplary component; and

Figure 5 is a schematic side view of a fourth exemplary component.

Detailed description of certain embodiments

In the following, like parts are denoted by like reference numerals.

15

Lengthening the pipe connecting the drain to the trap and making it curved might reduce the frequency with which trap bacteria may escape the drain sink, thus reducing transmission. In other words, the likelihood of a bacteria ascending from the drain/trap up to the sink (and then onwards), whether in an aerosolised droplet or as a
20 biofilm, may be reduced.

20

In the invention defined in the appended claims, the vertical drain pipe is replaced by a curved section, for example of copper pipe, orientated so the lumen was always descending on its course away from the sink. The lower end of this would be attached
25 to the trap or U bend. Optional and advantageous features of the invention are described in the dependent claims and summary of the present specification.

25

First example of a component for a pipe-line system for waste-water in a building

A first example of the invention (referred to herein as the “first exemplary component”) shall be discussed in more detail with reference to Figures 1A and 1B, which are
30 photographs of a first exemplary component 1 (Figure 2A) in accordance with the present invention.

30

With the curved drain splash back of the water from the traps to the drain would not
35 occur as the splash (backsplash droplets) would not be able to travel through the component. Bacterial biofilms would have further to grow over the (sometimes) dry

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tube, for example formed of antibacterial copper, before reaching the drain. Partial blockage downstream of the trap would be less likely to lead to trap water entering the sink as there would be more dead space above the trap.

- 5 On falling from the sink outlet water would hit a 'ski jump slope' (or similar splash reducing/preventing structure), as the copper pipe has a progressive bend. Unlike bacteria in trap water, any bacteria attached to the side of the device (that is, the component) would be less likely to splash upwards as the 'ski jump slope' would cause a gradual change in course.

10

In the event of drain contamination occurring (for example in a sink or washbasin) despite the component, as copper tube as shown in Figures 1A and 1B could easily be decontaminated in situ by the application of heat using an electric paint stripper. That would mean that any biofilms would have to re-grow before the risk of drain
15 contamination recurred.

Referring also to Figures 2A to 2C, generalised schematic views of the first exemplary component are shown. The photographs shown in Figures 1A and 1B show one possible implementation of the first exemplary component 1, which in the general case is
20 defined by its general shape, which is not limited to the specific angles, lengths, diameters and so forth illustrated in Figure 1A and 1B.

Figure 2A is a schematic plan view of the first exemplary component 1 (along the negative z direction as illustrated, Figure 2B is a schematic side view of the first
25 exemplary component 1 (along the negative x direction as illustrated), and Figure 2C is a schematic side view of the first exemplary component 1 from the opposite direction to Figure 2B (along the positive x direction as illustrated).

The first exemplary component 1 includes an inlet 2 connected to an outlet 3 by a tube 4
30 shaped such that there is no straight-line path passing uninterrupted through the tube 4 between the inlet 2 and outlet 3. The tube 4 is shaped such that it can be aligned relative to gravity with the inlet 2 above the outlet 3 and every part of the tube 4 sloping downwards. The inlet 2 and outlet 3 may be coupled to other elements of pipework connecting to the drain and trap respectively using any suitable method, for example O-
35 ring compression fittings. The tube 4 may be formed as a single, integral piece. Alternatively, the tube 4 may be formed from two or more sections which are joined or

bonded together. For example, as shown in Figures 1A and 1B, the tube 4 may be formed from sections of copper piping soldered or brazed together. In other implementations, the tube 4 may be formed from two or more sections formed using different materials.

5

In the case of the first exemplary component 1, the tube 4 is shaped to be generally helical and elliptical. Figures 2A to 2C are oriented such that the illustrated z -axis substantially corresponds to the vertical when installed (within for example within $\pm 5^\circ$ or within $\pm 10^\circ$ to account for practicalities of installation). Immediately below the inlet

10 2, the tube 4 enters a first bend 5 which curves about an axis parallel to the x -axis as illustrated so that the tube is diverted from being initially parallel to the vertical (z -axis as illustrated) to being aligned in a direction perpendicular to the illustrated x -axis and angled at a first angle θ_1 to the illustrated y -axis. The slope of the first bend 5 transitions gradually from vertical to the first angle θ_1 , similar to a 'ski jump slope'.

15 This may help to reduce or prevent generation of backsplash droplets from fluid drops falling in through the inlet 2 (or at least direct them away from straight back up the vertical). This may provide additional protection from potential infection even in the event that a biofilm is able to colonise all the way up to the first bend 5.

20 The tube 4 continues from the first bend 5 through a first straight section 6 oriented along the first angle θ_1 to ensure drainage of fluids in use. The first straight section 6 connects to a second bend 7 which curves clockwise about an axis parallel to the vertical (z -axis as illustrated) through 180° , finishing at an orientation perpendicular to the illustrated x -axis and angled at a second angle θ_2 to the illustrated y -axis. The first and

25 second angles θ_1 , θ_2 may be of equal magnitude (equivalently "slope"), however, this is not essential provided that the second angle θ_2 will continue to provide drainage of fluids in use.

From the exit of the second bend 7 the tube 4 continues along a second straight section

30 8 oriented along the second angle θ_2 . The second straight section 8 connects to a third bend 9 which curves clockwise about an axis parallel to the vertical (z -axis as illustrated) through 180° , finishing at an orientation perpendicular to the illustrated x -axis and angled at a third angle θ_3 to the illustrated y -axis. The second and third angles θ_2 , θ_3 may be of equal magnitude (equivalently "slope"), however, this is not essential

35 provided that the third angle θ_3 will continue to provide drainage of fluids in use.

Leaving the third bend 9, a third straight section 10 extending along the third angle θ_3 connects to a fourth and final bend 11 which curves about an axis parallel to the x -axis as illustrated from the third angle θ_3 back to parallel with the vertical (z -axis as illustrated) at the outlet 3.

5

In the example shown in Figures 1 and 2A to 2C, the first, second and third angles are all equal $\theta_1 = \theta_2 = \theta_3$, and the second straight section 8 is longer than the first straight section 6, such that the start and finish of the second straight section 8 are equally spaced about the inlet 2 in a direction parallel to the y -axis as illustrated. This configuration positions the inlet 2 and outlet 3 to be coincident along the vertical (z -axis as illustrated), and the equal angles $\theta_1 = \theta_2 = \theta_3$ mean that the first exemplary component 1 functions identically whichever of the inlet 2 and outlet 3 is installed upwards relative to the vertical (z -axis as illustrated). However, in other implementations of the first exemplary component 1, one or both of the second θ_2 and third θ_3 angles may be different from the first angle θ_1 . For example, it may be the case that $\theta_1 > \theta_2 > \theta_3$, i.e., that the pitch of the generally helical path decreases between the inlet 2 and the outlet 3 of the tube 4. Additionally or alternatively, the first 6 and third 10 straight sections need not be of equal length, and/or the second straight section 8 need not be centred about the inlet 2 or outlet 3 in a direction parallel to the y -axis as illustrated. In still further implementations, the second 7 and third bends 9 need not be through 180° about the vertical, and need not have the same radii of curvature (viewed along the vertical). For example, the radii of curvature of bends may increase between the inlet 2 and the outlet 3 of the tube. The requirement is that the angles θ_1 , θ_2 , θ_3 may provide continuous drainage for a range of possible orientations relative to the vertical (gravity) when installed.

In Figures 2A to 2C, the cross-section of the tube 4 being substantially constant in shape and area. However, this need not be the case and the cross-section of the tube 4 may vary from the inlet 2 to the outlet 3, provided that a component can be installed such that every part of the interior surface is sloped down for fluid drainage.

The first exemplary component 1 includes three straight sections 6, 8, 10 and four bends 5, 7, 9, 11 and has a generally elliptical path which extends over one full turn in the xy -plane. However, this is not required to be the case. More specifically, the first exemplary component may be modified to include a different number of straight sections and bends and to have a path which extends over less than (or more than) one

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full turn in the *xy*-plane, provided that there is no straight-line path passing uninterrupted through the tube 4 between the inlet 2 and outlet 3 and that the tube 4 can be aligned relative to gravity with the inlet 2 above the outlet 3 and every part of the tube 4 sloping downwards

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Provided that the tube 4 includes or is internally lined with anti-microbial material, it may be formed from materials other than copper. Suitable materials include (without being limited to) other metals such as stainless steel and brass, or plastics such as PVC and PP). Although the tube 4 of the first exemplary component 1 is a formed from one material (copper), in other examples the tube 4 may be formed from two or more different sections along the length of the path from the inlet 2 to the outlet 3, and these sections may be formed from different materials. Lead alloys may also be considered.

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Second example of a component for a pipe-line system for waste-water in a building

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Referring also to Figure 3, a schematic side view of a second example of a component 12 for a pipe-line system for waste-water in a building (hereinafter the “second exemplary component”) is shown (along the positive *x* direction as illustrated).

The second exemplary component 12 is the same as the first exemplary component 1, except that the first 5 and fourth 11 bends are omitted, such that the end of the first straight section 6 away from the second bend 7 provides the inlet 13 and the end of the third straight section 10 away from the third bend 9 provides the outlet 14. The inlet 13 is the same as the inlet 2, except that it is provided at the end of the first straight section 6 away from the second bend 7. Likewise, the outlet 14 is the same as the outlet 3, except that it is provided at the end of the third straight section away from the third bend 9.

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Whilst the first bend 5 and the fourth bend 11 are omitted, the second exemplary component 12 can provide the same advantageous effects as the first exemplary component 1. In particular, there is no direct path between the inlet 2 and outlet 3 for backsplash droplets, and the overall path length between a trap and a drain may be significantly increased. Connections of the inlet 2 and/or the outlet 3 to the rest of the pipe-line system for waste-water may made using usual methods such as O-ring compression fitting, soldering and so forth (depending on the materials of the tube 4 and the sections of the pipe-line system is it to be connected to). Connections of the inlet 2 and/or the outlet 3 may be made to connecting portions of the pipe-line system

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which are curved and/or straight, for example the inlet 2 and/or the outlet 3 may be connected to elbow sections (not shown) of the pipe-line system such that the combination of the second exemplary component 12 with the adjoining elbow sections (not shown) has a similar overall shape to the first exemplary component 1.

5

Third example of a component for a pipe-line system for waste-water in a building

Referring also to Figure 4, a schematic side view (along the negative x direction as illustrated) is shown for a third example of a component 15 for a pipe-line system for waste-water in a building (hereinafter the “third exemplary component”).

10

The third exemplary component 13 is shaped differently to the first exemplary component 1, but is the same as the first exemplary component 1 in relation to materials, applications and in all other respects except for the particular shape.

15

Tube 4 of the third exemplary component 13 is shaped to be generally serpentine, following a path which is substantially within the z - y plane as illustrated. Figure 4 is oriented such that the illustrated z -axis substantially corresponds to the vertical when installed (within for example $\pm 10^\circ$ to account for practicalities of installation).

20

Immediately below the inlet 2, the tube 4 enters a first bend 14 which curves about an axis parallel to the x -axis as illustrated so that the tube is diverted from being initially parallel to the vertical (z -axis as illustrated) to being aligned in a direction perpendicular to the illustrated x -axis and angled at a first angle θ_1 to the illustrated y -axis. The slope of the first bend 14 transitions gradually from vertical to the first angle θ_1 in the same way as the first bend 5 of the first exemplary component 1, providing the same effects to help to reduce or prevent generation of backsplash droplets from fluid dops falling in through the inlet 2 (or at least direct them away from straight back up the vertical). This may provide additional protection from potential infection even in the event that a biofilm is able to colonise all the way up to the first bend 14.

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30

The tube 4 continues from the first bend 14 through a first straight section 15 oriented along the first angle θ_1 to ensure drainage of fluids in use. The first straight section 15 connects to a second bend 16 which curves clockwise about an axis perpendicular to the yz -plane (parallel to the x -axis as illustrated) through a hairpin curve which finishes at an orientation perpendicular to the illustrated x -axis and angled at a second angle θ_2 to the illustrated y -axis. The entrance and exit from the second bend 16 are directed oppositely relative to the y -axis as illustrated. The first and second angles θ_1 , θ_2 may be

35

of equal magnitude (equivalently “slope”), however, this is not essential provided that the second angle θ_2 will continue to provide drainage of fluids in use. The first and second angles θ_1, θ_2 of the third exemplary component 13 need not be the same as those of the first exemplary component 1.

5

From the exit of the second bend 16 the tube 4 continues along a second straight section 17 oriented along the second angle θ_2 and heading in the opposite sense to the first straight section 15 relative to the illustrated y -axis. The second straight section 17 connects to a third bend 18 which curves anti-clockwise about an axis perpendicular to the yz -plane (parallel to the x -axis as illustrated) through a hairpin curve which finishes at an orientation perpendicular to the illustrated x -axis and angled at a third angle θ_3 to the illustrated y -axis. The entrance and exit from the third bend 18 are directed oppositely relative to the y -axis as illustrated. The second and third angles θ_2, θ_3 may be of equal magnitude (equivalently “slope”), however, this is not essential provided that the third angle θ_3 will continue to provide drainage of fluids in use. The second and third angles θ_2, θ_3 of the third exemplary component 13 need not be the same as those of the first exemplary component 1.

Leaving the third bend 18, a third straight section 19 extending along the third angle θ_3 and heading in the same sense as the first straight section 15 relative to the illustrated y -axis connects to a fourth and final bend 20 which curves about an axis parallel to the x -axis as illustrated from the third angle θ_3 back to parallel with the vertical (z -axis as illustrated) at the outlet 3.

Despite the different shape, the third exemplary component 13 may provide the same effects as the first exemplary component 1. In particular, there is no direct path between the inlet 2 and outlet 3 for backsplash droplets, and the overall path length between a trap and a drain may be significantly increased.

In terms of the materials, composition, and connections to the rest of the pipe-line system (in particular the drain and the trap), the third exemplary component 13 may be configured in any way described in relation to the first exemplary component 1

Fourth example of a component for a pipe-line system for waste-water in a building

Referring also to Figure 5, a schematic side view (along the negative x direction as illustrated) is shown for a fourth example of a component 21 for a pipe-line system for waste-water in a building (hereinafter the “fourth exemplary component”).

5 The fourth exemplary component 21 is the same as the third exemplary component 13, except that its tube 4 omits the third bend 18 and third straight section 19, whilst the second straight section 17 is shortened to have the same length as the first straight section 15. The end of the second straight section 17 extending away from the second bend 16 connects directly to the fourth bend 20, which is also rotated 180° about the
10 vertical (z -axis as illustrated) to make the connection. In this way, the tube 4 between the inlet 2 and the outlet 3 of the fourth exemplary component 21 follows a generally U-shaped path which lies within the yz -plane.

The fourth exemplary component 21 can provide the same effects as any of the first to
15 third exemplary components 1, 12, 13. In particular, there is no direct path between the inlet 2 and outlet 3 for backsplash droplets, and the overall path length between a trap and a drain may be significantly increased.

Applications

20 Installation locations for components 1, 12, 13, 21 according to the present specification are not particularly limited. Components 1, 12, 13, 21 may be sized for commercial, residential or industrial drains, and may be useful in any building or context in which there may be waste-water and infection control may be a concern. Such locations include (without being limited to) a house, a hospital, a farm, an abattoir
25 (slaughterhouse), a nursing home, an airport, a railway station, a plant for preparing, processing or manufacturing food, a restaurant, a nursery, a school, and so forth.

Components 1, 12, 13, 21 according to the present specification may be used with a variety of different kinds of sanitaryware product. The only requirement for a
30 compatible sanitaryware product is that it has a drain which can be connected to the inlet 2 of the component 1, 12, 13, 21. Suitable sanitaryware products include (without being limited to) sinks and washbasins, showers and baths, bidets, dishwashers and washing machines, sluice rooms and wet rooms, and so forth.

35 Components 1, 12, 13, 21 according to the present specification may be used with a variety of different kinds of trap. The only requirement is that a compatible trap can be

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connected to the outlet 3 of the component 1, 12, 13, 21. Suitable traps include (without being limited to) P traps, S traps, Q traps, gully traps, bottle traps, intercepting traps, grease traps, drum traps, running traps, straight through traps, low-level bath traps, building traps, U-bends, and so forth.

5

When installed, the outlet 3 of a component 1, 12, 13, 21 according to the present specification is typically connected to an inlet of the trap, whilst the outlet of the trap may be connected to a sewage system, a septic tank and so forth.

10 Drying method

As previously explained, the risk from the potential reservoir of bacteria and other pathogens in a trap cannot be removed, only mitigated.

15 In examples in which at least a section of the tube 4 is formed from a metal, or another material which can withstand application of elevated temperatures, a method of drying or even decontaminating a component 1, 12, 13, 21 may be applied. Use of a metal tube 4, or at least a tube 4 incorporating a metal segment, may be preferable due to the high thermal conductance of metals effectively transferring heat to the interior surfaces.

20 A heat source, for example a heat gun such as paint stripper or hairdryer, may be used to locally apply heat to a part of the tube 4. The heat applied will be conducted to the interior surfaces of the tube 4, accelerating drying of residual moisture. It is harder for a biofilm to colonise across a dry material, and if a biofilm has already penetrated partway through the tube 4 prior to the heat treatment, drying the biofilm out may
25 retard growth.

Any elevation of temperature above ambient will accelerate drying, and the higher the temperature the faster the interior of the tube 4 will dry. Drying of any biofilm present may help to facilitate a subsequent rinsing operation by reducing the adhesion of such a
30 biofilm to an internal surface of the tube 4 by causing spallation of the drying biofilm.

If the temperature of internal surfaces of the tube 4 may be increased to a range between 60°C and 100°C (range including end-points), then in addition to drying the elevated temperatures may help to kill some bacteria and other biofilm forming
35 organisms.

To allow enough time for applied heat to fully act on a biofilm on an internal surface during a decontamination process, it may be necessary to apply a heat source, for example an electric paint stripper or similar heat gun, for at least five minutes or at least ten minutes. The precise times for a given component 1, 12, 13, 21 and installation
5 may be readily determined by routine experimentation.

This drying method can be carried out when the component 1, 12, 13 21 is installed between a drain and a trap, which makes the method simple, convenient and fully compatible with existing decontamination methods such as chemical treatment and/or
10 rinsing. For example, a sink could be treated by pouring chemicals (e.g. bleach) into the drain, followed after an interval to allow chemical action by rinsing. After the rinsing, the heat treatment may be applied, drying out at least part of an interior surface of the tube 4. If the chemical used to treat the sink drain will not generate dangerous fumes on heating, the heat treatment could also be applied after applying
15 chemicals but before rinsing to increase rates of reaction.

The length of the tube 4 in components 1, 12, 13, 21 may have an advantage beyond simply increasing the total path length between the trap and the drain. For example, in relation to the heating method, if the heat source is applied to a mid-point of the tube 4,
20 then heat losses along the length of the tube may allow a high temperature to be sustained at the application point, whilst reducing temperature increases at the inlet 2 and outlet 3. For example, the heat source may be applied to the middle of the second straight sections 8, 17 of the first to third exemplary components 1, 12, 13, or the second bend 16 of the fourth exemplary component 21. This may help to reduce/avoid undue
25 thermal stresses and/or aging on components of the pipe-line system connected to the inlet 2 and/or outlet 3. For example, polymeric components connected to the inlet 2 and/or outlet 3 (or rubber O-rings used in compression fittings which may be susceptible to thermally induced embrittlement).

Preferably, the tube 4 of a component 1, 12, 13, 21 intended to make use of the drying method may have a length such that when its midpoint is raised to a temperature between 60°C and 100°C, the maximum temperature at the inlet 2 and/or outlet 3 may remains at least 10°C lower than a temperature at the point of applying the heat source. This may be controlled via the length and materials of the tube, and may be readily
30 modelled based on thermal conductance and geometry of the tube 4, combined with
35 typical surface heat loss assumptions.

Results of a blinded, randomised paired comparison trial of the component

New drainage was installed in an outpatients facility at Great Ormond Street Hospital in May, 2023 and monthly bacterial counts were conducted on swabs taken from the 36 sink outlets from June 2023 to Mar 2024 (excepting August 2023). Eighteen of the sinks had been randomised to include the component, specifically the first exemplary component 1. The other eighteen sinks had standard plumbing. Each sink that had a first exemplary component 1 had a paired control without a first exemplary component 1.

The paired design helped to reduce effects of other factors such as sink usage. Before the study it was decided on certain target bacteria that were of interest to control, because they live in sink outlets, cause infections of humans and are multi-antibiotic resistance or can acquire multi-resistance. The target bacteria are *Stenotrophomonas maltophilia*, *Pseudomonas aeruginosa*, the Enterobacteriales, and *Acinetobacter baumannii*.

The geometric means (over months) of the counts of target bacteria in the device-plumbed sinks were on average lower than those in their paired controls, with a p-value of $p = 0.0127$ using a sign test 2 tailed analysis. A p-value of less than 0.05 corresponds to significance using this statistical test. This finding supports the inclusion of the first exemplary components 1 in a pipe-line waste-water system, as a means of reducing the risk of transmission of multi-resistant bacterial pathogens.

Modifications

It will be appreciated that various modifications may be made to the embodiments hereinbefore described. Such modifications may involve equivalent and other features which are already known in the design and use of components for pipe-line systems for waste-water in a building, and which may be used instead of or in addition to features already described herein. Features of one embodiment may be replaced or supplemented by features of another embodiment.

In each of the first 1, third 13 and fourth 21 exemplary components, the slope of the first bend 5, 14 transitions gradually from vertical to the first angle θ_1 , similar to a 'ski-jump slope'. This can help to reduce or prevent generation of backsplash droplets from fluid drops falling in through the inlet 2. However, the section of any component 1, 12, 13, 21

immediately following the inlet 2 may additionally or alternatively include any known type of splash reducing/preventing structure. For example, instead of the 'ski jump slope' being curved it may be made up of one or more adjacent and linearly sloped (i.e., not individually curved) sections having a slope between θ_i and vertical. Additionally
5 or alternatively, protrusions may be supported on an internal wall immediately following the inlet 2 (for example in/before the first bend 5, 14). Structures such as these can help to diffuse incident flow and thereby reduce or prevent backsplash droplets from passing back up to the drain.

10 Splash reducing/preventing structures known from use in urinals and/or sinks may also be included immediately following the inlet 2 (for example in/before the first bend 5, 14). Whilst known for such purposes, to the applicant's knowledge such structures have not previously been used below a drain, within a channel connecting the drain to
15 tube 4 proximate to the inlet 2 (for example, within 10% or less of a total path length between the inlet 2 and the outlet 3. Of course, the specific location for placement of such structures will vary depending on the shape of the tube 4 following the inlet and the intended installation location, and in other examples splash reducing/preventing structure(s) may be positioned further away from the inlet 2.

20 The inlet 2 and outlet 3 have been described as being couplable to the rest of the pipe-line system using O-ring compression fittings. However, alternative methods of fluid-tight sealing/coupling may be used instead and include (without being limited to) applying adhesives, screwing directly onto the component, and (in the case that the
25 parts to be connected are both formed from metals) brazing or soldering.

Particular options and alternatives are specified in the dependent claims appended hereto, and in the preceding summary section.

30 Although claims have been formulated in this application to particular combinations of features, it should be understood that the scope of the disclosure of the present invention also includes any novel features or any novel combination of features disclosed herein either explicitly or implicitly or any generalization thereof, whether or not it relates to the same invention as presently claimed in any claim and whether or
35 not it mitigates any or all of the same technical problems as does the present invention. The applicants hereby give notice that new claims may be formulated to such features

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and/or combinations of such features during the prosecution of the present application or of any further application derived therefrom.

Claims

1. A component for a pipe-line system for waste-water in a building, comprising an inlet connected to an outlet by a tube shaped such that:
 - 5 there is no straight-line path passing uninterrupted through the tube between the inlet and outlet, the tube comprises a portion which follows a U-shaped path;
the tube can be aligned relative to gravity with the inlet above the outlet and every part of the tube sloping downwards; and
wherein the tube comprises anti-microbial material or is internally lined with
10 anti-microbial material.
2. The component of claim 1, wherein the tube comprises a structure proximate to the inlet and configured to reduce or prevent generation of backsplash droplets in response to fluid incident through the inlet.
15
3. The component of claim 1 or 2, wherein the structure comprises a slope and/or a curvature of the tube wall following the inlet.
4. The component of any one of claims 1 to 3, wherein the structure comprises a
20 plurality of protrusions supported on a portion of the tube wall onto which a fluid incident through the inlet impacts.
5. The component of any one of claims 1 to 4, wherein the structure comprises a mesh and/or a grating spanning the tube.
25
6. The component of any one of claims 1 to 5, wherein the tube comprises a portion which follows a helical path.
7. The component of claim 6, wherein a pitch and/or a radius of the helical path
30 varies along an axis of the helical path.
8. The component of any one of claims 1 to 7, wherein the tube comprises a portion which follows a serpentine path.
- 35 9. The component of any one of claims 1 to 8, wherein the anti-microbial material is a metal.

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10. The component of claim 9, wherein the metal comprises copper.

11. The component of claim 9 or claim 10, wherein the tube is composed of the
5 metal.

12. The component of claim 11, wherein a length of the tube is such that when a
midpoint of the tube is raised to a temperature between 60 and 100 degrees Celsius, the
maximum of a temperature at the inlet and a temperature at the outlet remains at least
10 10 degrees Celsius lower than the temperature at the midpoint of the tube.

13. A pipe-line system for waste-water in a building, comprising a component
according to any one of claims 1 to 12 connected between a drain and a trap.

14. A pipe-line system for waste-water in a building comprising a component
connected between a drain and a trap, the component comprising an inlet connected to
an outlet by a tube shaped such that:

there is no straight-line path passing uninterrupted through the tube between
the inlet and outlet;

20 the tube is arranged relative to gravity with the inlet above the outlet and every
part of the tube sloping downwards.

15. A system according to claim 13 or claim 14, wherein the inclusion of the
component increases a path length between the drain and the trap by a factor of at least
25 1.5 compared to connecting the drain directly to the trap.

16. The pipe-line system for waste-water in a building according to any one of
claims 13 to 16, wherein water is not retained in any portion of the component during
normal use.

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17. A kit of parts comprising:
the component of any one of claims 1 to 12;
a first connector for connecting the inlet of the component to a drain; and
a second connector for connecting the outlet of the component to a trap.

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- 25 -

18. A method of fitting the component of any one of claims 1 to 12 to a pipe-line system for waste-water in a building comprising a drain connected to a trap, the method comprising:

5 replacing all or part of a connection between the drain and the trap with the component.

19. A method for a system according to any one of claims 13 to 17, wherein the tube of the component is formed of metal, comprising using a heat source to heat the tube to a temperature between 60 and 100 degrees Celsius for a time period at least long
10 enough to cause drying of the interior surface of the tube.

1/3

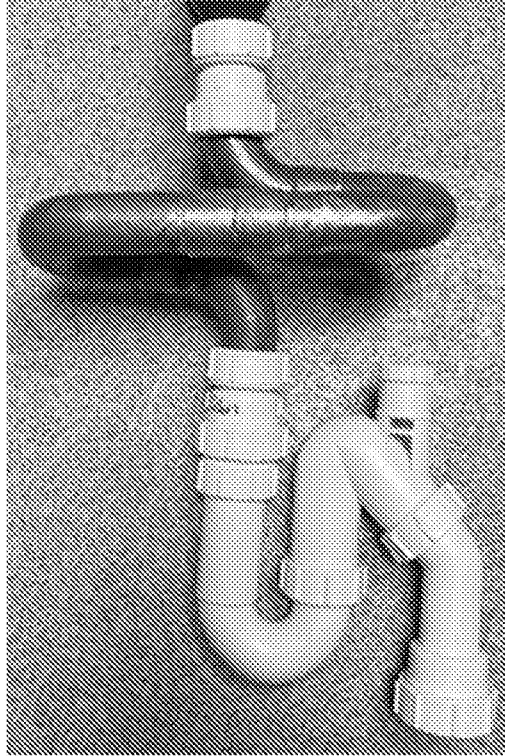


Fig. 1A

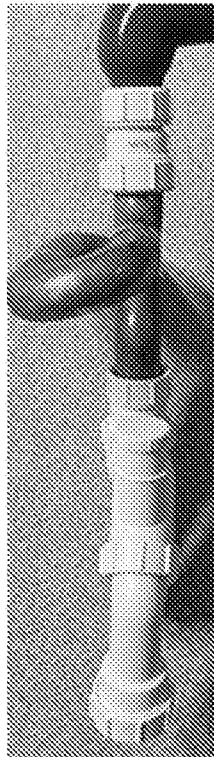


Fig. 1B

2/3

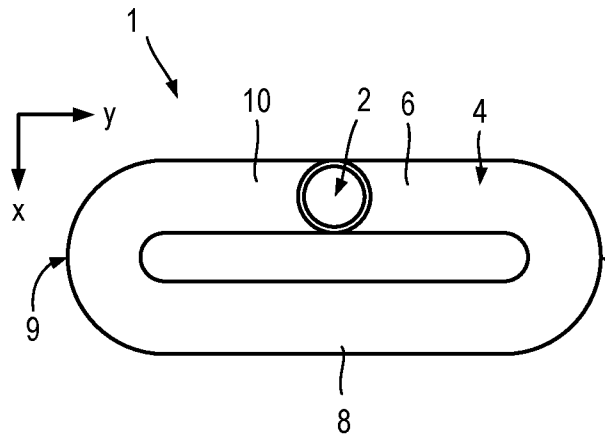


Fig. 2A

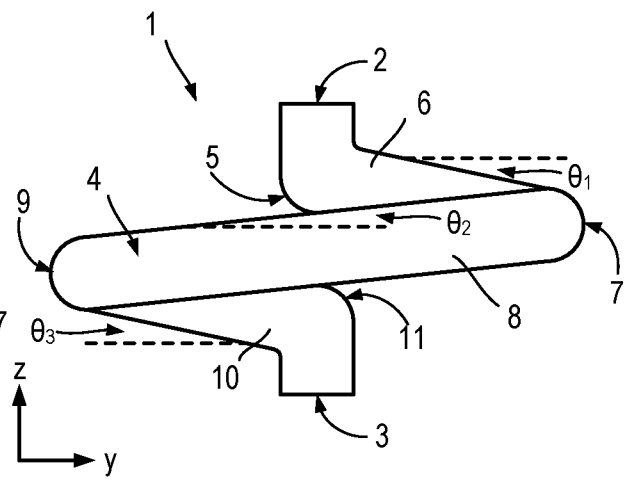


Fig. 2B

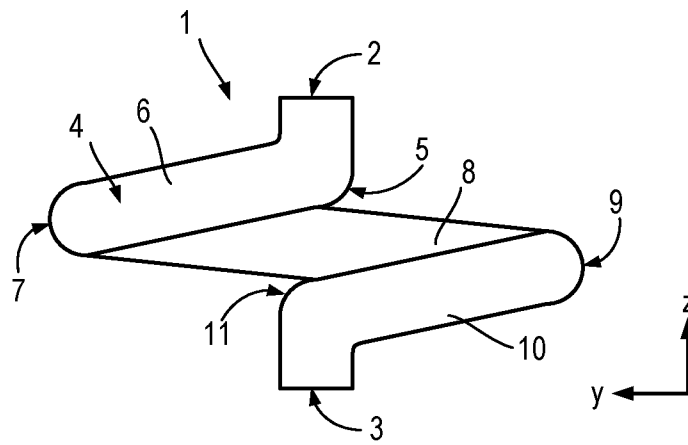


Fig. 2C

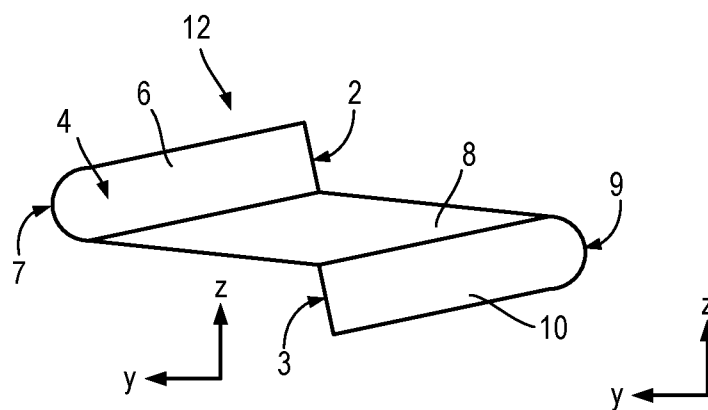


Fig. 3

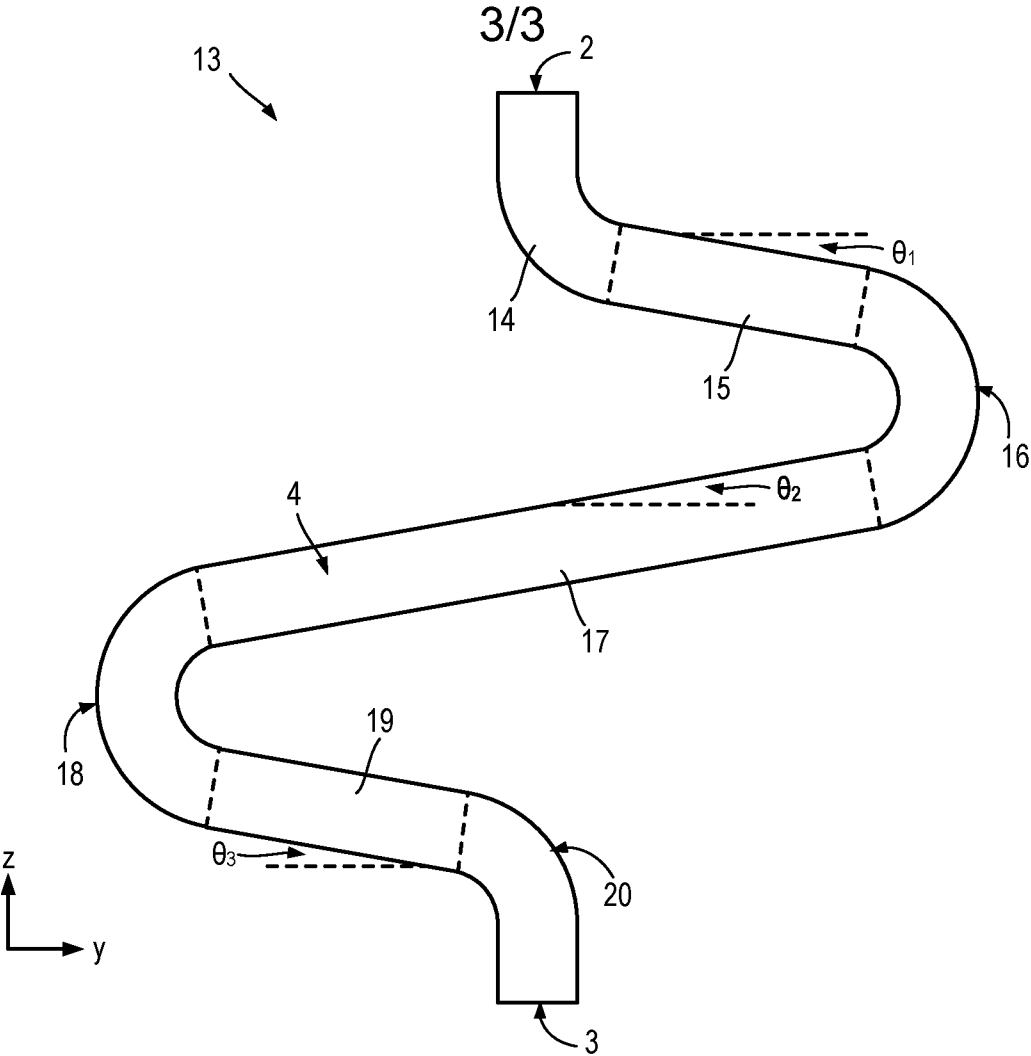


Fig. 4

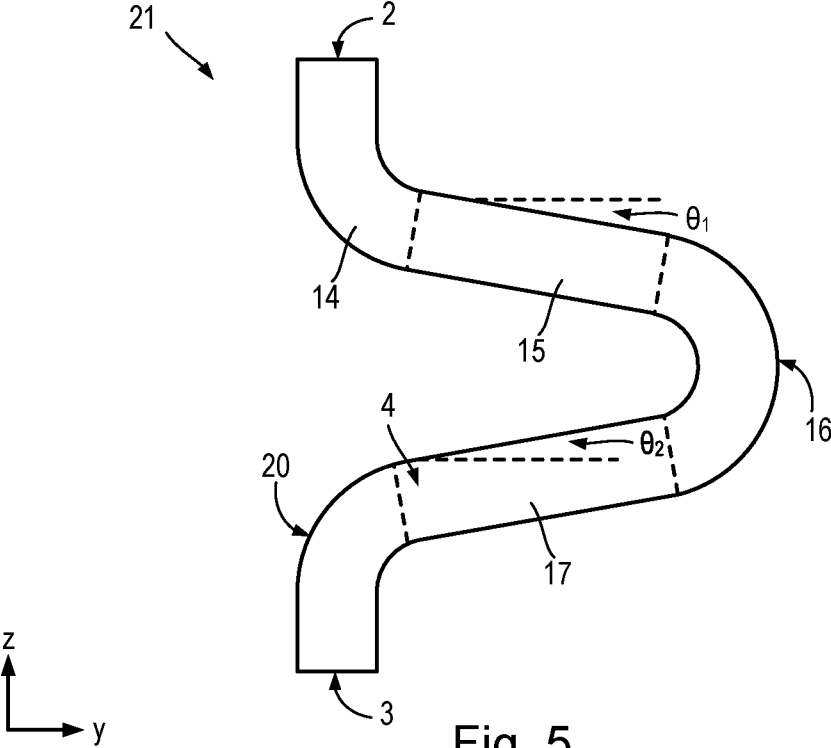


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2024/050800

A. CLASSIFICATION OF SUBJECT MATTER

INV. E03C1/122 E03C1/126
ADD. E03C1/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E03C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CA 3 040 082 A1 (BATRIK MEDICAL MFG INC [CA]) 19 October 2019 (2019-10-19)	1-3,8, 13,14, 16-19
Y	paragraphs [0001] - [0045]; figure 1	5
A		4,6,7, 9-12,15
X	JP S50 27608 B1 (HITACHI CO LTD) 9 September 1975 (1975-09-09)	1-3, 6-11, 13-18
A	columns 1-4; figures 1-5	12
X	CA 2 200 233 A1 (SALASIDIS ROBERT [CA]) 18 September 1998 (1998-09-18)	1-3, 6-11, 13-15, 17,18
A	pages 1-6; figures 1, 2	12
	- / - -	



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

7 June 2024

Date of mailing of the international search report

25/06/2024

Name and mailing address of the ISA/

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Authorized officer

Posavec, Daniel

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2024/050800

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims;; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No

PCT/GB2024/050800

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 200 330 985 Y1 (SIM DEUK-SEOP) 22 October 2003 (2003-10-22) abstract; figure 8 -----	5
A	CN 211 688 507 U (LIU YIYUN) 16 October 2020 (2020-10-16) abstract; figure 1 -----	1 - 19
A	EP 3 236 191 A1 (ECODRAIN INC [CA]) 25 October 2017 (2017-10-25) abstract; figures 6A, 6B -----	1 - 19

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2024/050800

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CA 3040082	A1	19-10-2019	CA 3040082 A1 19-10-2019
		US 2019323218 A1	24-10-2019
JP S5027608	B1	09-09-1975	NONE
CA 2200233	A1	18-09-1998	NONE
KR 200330985	Y1	22-10-2003	NONE
CN 211688507	U	16-10-2020	NONE
EP 3236191	A1	25-10-2017	CA 2964399 A1 12-10-2017
		EP 3236191 A1	25-10-2017
		US 2017292790 A1	12-10-2017

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-19

A component for a pipe-line system for waste-water in a building, comprising an inlet connected to an outlet by a tube shaped such that: there is no straight-line path passing uninterrupted through the tube between the inlet and outlet, the tube comprises a portion which follows a U-shaped path; the tube can be aligned relative to gravity with the inlet above the outlet and every part of the tube sloping downwards; and wherein the tube comprises anti-microbial material or is internally lined with anti-microbial material.

1.1. claims: 14(completely); 15, 16, 19(partially)

A pipe-line system for waste-water in a building comprising a component connected between a drain and a trap, the component comprising an inlet connected to an outlet by a tube shaped such that:there is no straight-line path passing uninterrupted through the tube between the inlet and outlet;the tube is arranged relative to gravity with the inlet above the outlet and every part of the tube sloping downwards.
